Flood Risk Report

For study area including: Watershed USA, Village of Coastland, Village of Drytown, City of Floodville, City of Metropolis, Town of Waterloo, County A*, County B*, and County C*

**Spans more than one watershed. This report covers only the area within the studied watershed.*

Report Number 001

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FEMA

RiskMAP
Increasing Resilience Together

Preface

The Department of Homeland Security (DHS), Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) program provides States, Tribes and local communities with flood risk information and tools that they can use to increase their resilience to flooding and better protect their citizens. By pairing accurate floodplain maps with risk assessment tools and planning and outreach support, Risk MAP has transformed traditional flood mapping efforts into an integrated process of identifying, assessing, communicating, planning for, and mitigating flood-related risks.

This Flood Risk Report (FRR) provides non-regulatory information to help local or Tribal officials, floodplain managers, planners, emergency managers, and others better understand their flood risk, take steps to mitigate those risks, and communicate those risks to their citizens and local businesses.

Because flood risk often extends beyond community limits, the FRR provides flood risk data for the entire study area as well as for each individual community. This also emphasizes that flood risk reduction activities may impact areas beyond jurisdictional boundaries.

Flood risk is always changing, and there may be other studies, reports, or other sources of information available that provide information that is more comprehensive. The FRR is not intended to be regulatory or the final authoritative source of all flood risk data in the project area. Rather, it should be used in conjunction with other data sources to provide a comprehensive picture of flood risk within the project area.

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FLOOD RISK REPORT

1. Introduction

1.1 About Flood Risk

Flooding is a natural part of our world and our communities. It becomes a hazard only when it intersects with the built environment.

Floods are naturally occurring phenomena that can and do happen almost anywhere. In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Mild flood losses may have little impact on people or property, such as damage to landscaping or the generation of unwanted debris. Severe flood losses can destroy buildings, crops, and cause severe injuries or death.

Calculating Flood Risk

It is not enough to simply identify where flooding may occur. Just because one knows where a flood occurs does not mean they know the risk of flooding. The most common method for determining flood risk, also referred to as vulnerability, is to identify the probability of flooding and the consequences of flooding:

Flood Risk (or Vulnerability) **= Probability x Consequences**; where

Probability = the likelihood of occurrence
Consequences = the estimated impacts associated with the occurrence

- The probability of a flood is the likelihood that a flood will occur. The probability of flooding can change based on physical, environmental, and/or engineering factors. Factors affecting the probability that a flood will impact an area range from changing weather patterns to the existence of mitigation projects. The ability to assess the probability of a flood, and the level of accuracy for that assessment, is also influenced by modeling methodology advancements, better knowledge, and longer periods of record for the water body in question.
- The consequences of a flood are the estimated impacts associated with the flood occurrence. Consequences relate to humans activities within an area and how a flood impacts the natural and built environment.

Which picture below shows more flood risk?

Even if you assume that the flood in both pictures was the same probability- let's say a 10%-percent-annual-chance flood -- the consequences in terms of property damage and potential injury as a result of the flood in the bottom picture are much more severe. Therefore, the flood risk in the area shown on the bottom picture is higher.

Risk MAP Flood Risk Products

Through Risk MAP, FEMA provides communities with updated Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) that focus on the probability of floods and describe where and how often flooding may occur. FEMA understands that flood risk is dynamic and that flooding does not stop at a line on a map, and provides the following flood risk products:

Whether or not an area might flood is one consideration. The extent to which it might flood adds a necessary dimension to that understanding.

Vulnerability of infrastructure is another important consideration.

- A Flood Risk Report (FRR) that presents key risk analysis data for the study area.
- A Flood Risk Map (FRM), found in Section 3.1 of this document, shows risk areas at risk and is provided as an exhibit within the FRR. More information about the data shown on the map can be found in Section 2.
- A Flood Risk Database (FRD) houses the flood risk data developed during the course of the flood risk analysis to the raw flood risk data that can be used and updated by the community. After the Risk MAP study is complete, this data can be used in many ways to visualize and communicate flood risk within the study area.

These products provide flood risk information at both the study area level and community level (for those portions of each community within the study area). They demonstrate how decisions made within a study area can impact properties downstream, upstream, or both. Community-level information is particularly useful for mitigation planning and emergency management activities, which often occur at a jurisdictional level.

1.2 Uses of this Report

The goal of this report is to help inform and enable communities and Tribes take action to reduce flood risk. State, local, and Tribal officials can use the summary information provided in this report, in conjunction with the data in the FRD, to:

- Update local hazard mitigation plans – As required by the 2000 Federal Stafford Act, local hazard mitigation plans must be updated every five (5) years. Summary information presented in Section 3 of this report and the Flood Risk Map can be used to identify areas that may need additional focus when updating the risk assessment section of a local hazard mitigation plan. Information found in Section 4 pertains to the different mitigation techniques and programs and can be used to inform decisions related to the mitigation strategy of local plans.
- Update community comprehensive plans – Planners can use flood risk information in the development and/or update of comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes may be changed to better provide for appropriate land uses in high hazard areas.
- Update emergency operations and response plans – Emergency managers can identify low risk areas for potential evacuation and sheltering, and can assist first responders in avoidance of areas of high depth flood water. Risk assessment results information may show vulnerable areas, facilities and infrastructure for which planning for continuity of operations plans (COOP), continuity of government (COG) plans, and emergency operations plans (EOP) would be essential.
Develop hazard mitigation projects – Local officials (e.g., planners,

Flooding along the Wabash River contributed to Clark County, Illinois' Federal disaster declaration on June 24, 2008.

public works officials) can use flood risk information to re-evaluate and prioritize mitigation actions in local hazard mitigation plans.

- Communicate flood risk – Local officials can use the information in this report to communicate with property owners, business owners, and other citizens about flood risks, changes since the last FIRM, and areas of mitigation interest. The format of the report allows community information to be extracted in a fact sheet format.
- Inform the modification of development standards – Floodplain managers, planners and public works officials can use information in this report to support the adjustment of development standards for certain locations. For example, heavily developed areas tend to increase floodwater runoff because paved surfaces cannot absorb water, indicating a need to adopt or revise standards that provide for appropriate stormwater retention.

The flood risk products provided under Risk MAP are "Non-regulatory" products. They are available and intended for community use, but are not tied to the regulatory development and insurance requirements of the National Flood Insurance Program nor are required to be used. They may be used as regulatory products by communities if state and local enabling authorities authorize their use.

Possible users of this report include:

- Local Elected Officials
- Floodplain Managers
- Community Planners
- Emergency Managers
- Public Works Officials
- Other Special Interests (e.g., watershed conservation groups, environmental awareness organizations, etc.)

1.3 Sources of Risk Assessment Data Used

To assess potential community losses or the consequences portion of the "risk," equation, the following data was collected:

- Information about local assets or resources at risk of flooding
- Information about the physical features and human activities that contribute to that risk
- Information about where the risk is most severe

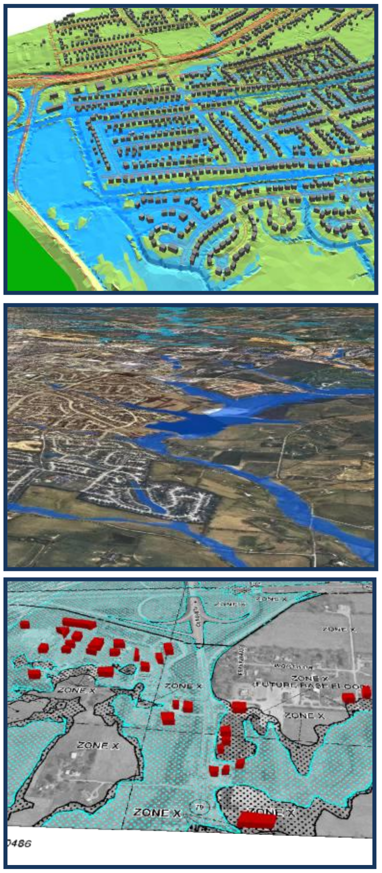
The sources of risk information FEMA used to develop this report included:

- FEMA generated HAZUS-MH analyses
- New engineering analyses (e.g., hydrology and hydraulics modeling) to develop new flood boundaries

- Locally-supplied data (see Appendix C for a description)
- Sources identified during the Discovery process

1.4 Related Resources

For a more comprehensive picture of a community's flood risk, FEMA recommends that State and local officials use the information provided in this report in conjunction with other sources of flood risk data, such as those listed below.



Examples of how FEMA data can be leveraged to identify and measure vulnerability.

- Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs). This information indicates areas with specific flood hazards by identifying the limit and extent of the 1-percent-annual-chance floodplain and the 0.2-percent-annual-chance floodplain. FIRMs and FISs do not identify all floodplains in a study area. The FIS includes summary information regarding other frequencies of flooding, as well as flood profiles for riverine sources of flooding. In rural areas, and areas for which flood hazard data are not available, the 1-percent-annual-chance floodplain may not be identified. In addition, the 1-percent-annual-chance floodplain may not be identified for flooding sources with very small drainage areas (less than 1 square mile).

- Flood or multi-hazard mitigation plans. Local hazard mitigation plans include risk assessments that contain flood risk information and mitigation strategies that identify community priorities and actions to reduce flood risk. This report was informed by any existing mitigation plans in the study area.

- Other risk assessment reports. HAZUS-MH, a free risk assessment software application from FEMA, is the most widely used flood risk assessment tool available. HAZUS-MH can run different scenario floods (riverine and coastal) to determine how much damage might occur as a result. HAZUS-MH can also be used by community officials to evaluate flood damage that can occur based on new/proposed mitigation projects or future development patterns and practices. HAZUS-MH can also run specialized risk assessments such as what happens when a dam or levee fails. Flood risk assessment tools are available through other agencies as well, including the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE). Other watershed reports may exist that have a different focus, such as water quality, but that may also contain flood risk and risk assessment information. See Appendix B for additional resources.

Flooding impacts non-populated areas too, such as agricultural lands and wildlife habitats.

State and Local Hazard Mitigation Plans are required to have a comprehensive all-hazard risk assessment. The flood risk analyses in the FRR, FRM, and FRD can inform the flood hazard portion of a community's or state's risk assessment. Further, data in the flood risk database can be used to develop information which meets the requirements for risk assessments as it relates to the hazard of flood in hazard mitigation plans.

2. Risk Analysis

2.1 Overview

Flood hazard identification uses FIRMs and FIS identify where flooding can occur along with the probability and depth of that flooding. Flood risk assessment is the systematic approach to identify how flooding impacts the environment. In hazard mitigation planning, flood risk assessments are the basis for mitigation strategies and actions by defining the hazard and enabling informed decision making. To fully assess flood risk requires the following:

- Identification of the flooding source and determination of the probability of occurrence of the flood hazard
- Development of a complete profile of the flood hazard including historical occurrence and previous impacts
- Inventory of assets located in the identified flood hazard area
- Estimation of potential future flood losses caused by exposure to the area of flood hazard

Flood risk analyses are different methods used in flood risk assessment to help quantify and communicate flood risk. Flood risk analysis can be done on a large scale (state, community) level and on a very small scale (parcel, census block). Advantages of large scale flood risk analysis, especially at the watershed level, can identify how actions and development in one community can affect areas up- and downstream. On the parcel or census block level, flood risk analysis can provide actionable data to individual property owners so they can take appropriate mitigation actions.

2.2 Analysis of Risk

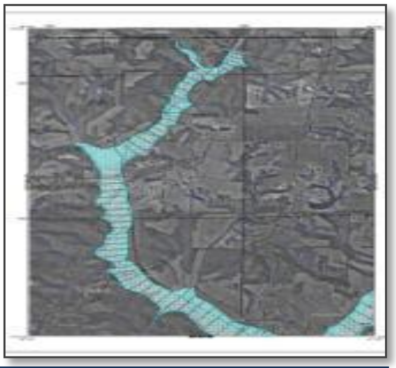
The FRR, FRM, and FRD contain four general types of risk analysis to help describe and visualize the flood risk at the jurisdictional levels:

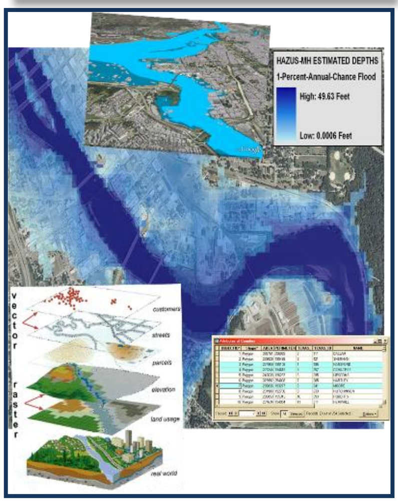
1. Changes Since Last FIRM
2. Water Surface, Flood Depth and Analysis Grids
3. HAZUS Estimated Loss Information
4. *Areas of Mitigation Interest*

2.2.1 Changes Since Last FIRM

The Changes Since Last FIRM (CSLF) dataset, stored in the FRD and shown in Section 3 of this report, shows where changes to flood risk may occurred since the county's last FIRM[1] was developed. Communities can use this information to update their mitigation plans, specifically quantifying "what is at risk" and identifying possible mitigation activities.

[1] **Note**: If the existing effective FIRM has not been modernized or is not in the countywide format, this information will not be included.





Floodplain maps have evolved considerably from the older paper-based FIRMs to the latest digital products and datasets.

The Changes Since Last FIRM dataset identifies changes in the Special Flood Hazard Area and floodway boundary changes since the previous mapFIRM was developed. These datasets quantify land area increases and decreases to the SFHA and floodway, as well as areas where the flood zone designation has changed (e.g., Zone A to AE, AE to VE, shaded Zone X protected by levee to AE for de-accredited levees). *These areas of change are also compared to the built environment and expressed as an estimated number of buildings and population affected by each change*.

The Changes Since Last FIRM dataset is created in areas that were previously mapped using digital FIRMs. The Changes Since Last FIRM dataset for this project area includes:

- Any changes to the existing floodplain designations (Zone A to Zone AE for example)
- Any changes to the extent of the mapped floodway
- *Structures: The total estimated count of affected buildings within the area of change. The e-data will only be made available in cases where the local jurisdiction is able to provide accurate building footprint data indicating the location of structures in and adjacent to the identified floodplains).*
- *Population: The total estimated affected population within the area of change. The data will only be made available in cases where the local jurisdiction is able to provide population data that accompanies the structure data noted above.*

Within the FRD, additional data may be provided called contributing engineering factors. These will not be shown in the FRR. These data are digital attributes for the areas of change and may include:

  - Changes in peak discharges
  - Changes to the modeling methodology (e.g., tide gage analysis)
  - Changes in flood control structures (e.g., dams, levees, groins and breakwaters)
  - Changes to hydraulic structures (e.g., bridges, culverts)
  - Sedimentation
  - Erosion
  - Man-made changes to the channel (e.g., realignment, improvement) Changes occurred to runoff (if any)

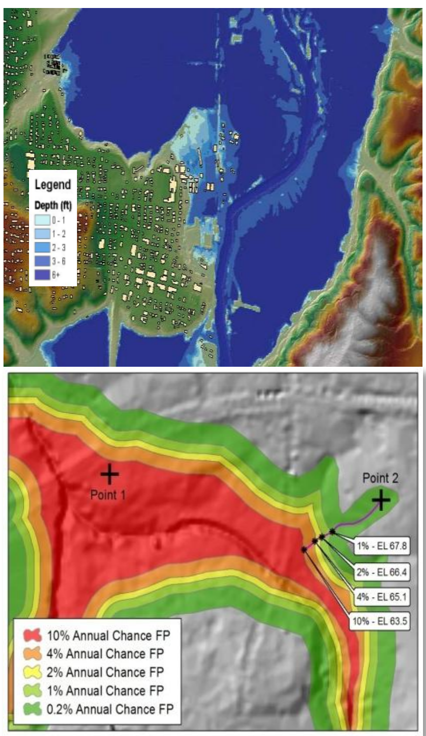
CSLF data can be used to communicate changes in the physical flood hazard area (size, location) as part of the release of new FIRMS. It can also be used in the development or update of hazard mitigation plans to describe changes in hazard as part of the hazard profile.

CLSF Data is shown in the FRR, and underlying data is stored in the FRD.

- Changes to the primary frontal dunes (if coastal area)

It should be noted that contributing engineering factors will only be identified in cases where the factor is identified as a change since the last FIRM was published. Within the scope of a typical flood study, there will always be limitations on identifying factors contributing to the floodplain change. As such, the intent of this dataset is to provide a general sense of why the floodplain has changed rather than explaining the reason for each and every change.

2.2.2 Water Surface, Flood Depth and Analysis Grids



Grid data can make flood mapping more informative. The top image is a flood depth grid showing relative depths of water in a scenario flood event. The bottom image is a percent annual chance of flooding grid which shows inundation areas of various frequency floods.

Grids are FEMA datasets provided in the FRD to better describe the risk of the flood hazard. While the FIRM and FIS describe "what" is at risk by identifying the hazard areas, water surface, flood depth and analysis grids can help define "how bad" the risk is within those identified areas. These grids are intended to be used by communities for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. Grids provided in the FRD for this project area include:

- Water Surface Elevation Grids: This dataset represents the raw results of the hydrologic and hydraulic analysis before adjustments are made to account for influences associated with other flooding sources.
- Flood Depth Grids (for the flood frequencies included in the FIS): The multi-frequency flood depth and analysis grids show depth, which is calculated as the difference (in feet) between the water surface elevation and the ground, and relies on the Water Surface Elevation Grid. Five grids will be delivered for riverine (non-leveed) areas for the standard flood frequencies (10%, 4%, 2%, 1% and 0.2%). Coastal and levee areas only receive the 1-percent annual chance grid.
- Percent Annual Chance of Flooding Grid: A grid dataset that represents the percent-annual-chance of flooding for locations along a flooding source. This grid uses the five standard flood frequencies.
- Probability of Flooding in a 30-Year Period Grid: A grid dataset that represents the estimated likelihood of flooding at least once within a 30-year period, which is the average lifespan for a home mortgage, for all locations within the extent of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplain.
- *Water Surface Elevation Change Grid: This dataset provides the ability to see vertical changes in the water surface elevation between the existing FIRM and the revised FIRM. This dataset would be the equivalent of the Changes Since Last FIRM dataset, but as a vertical analysis as opposed to a horizontal analysis since last FIRM.*

Grid data can be used to communicate the variability of floodplains such as where floodplains are particularly deep or hazardous, where residual risks lie behind levees, and where losses may be great after a flood event. For mitigation planning, grid data can inform the hazard profile and vulnerability analysis (what is at risk for different frequencies) and can be used for preliminary benefit-cost analysis screening. For floodplain management, higher regulatory standards can be developed in higher hazard flood prone areas (i.e., 10% chance floodplains or deep floodplains).

Grid data is stored in the FRD and a list of available grid data is provided in the FRR. Visualizations of grids (maps) are not provided.

- *<u>1-Percent Plus Flood Depth Grids</u>: This riverine-only dataset communicates the inherent uncertainty associated with the 1-percent- annual-chance flood elevation band by highlight the areas subject to inundation by the upper limit of the 1-percent- annual-chance flood discharge confidence interval.*
- *<u>Velocity Grids</u>: This dataset describes the average flood velocity that occurs within the floodplain. Velocity Grids can be used to increase public awareness of flood hazards associated with rapidly moving floodwaters.*
- *<u>Top of Levee Depth Grids:</u> This dataset allows for visualization and flood loss calculation for worst case scenarios in areas protected by levees.*
- *<u>Toe of Levee Depth Grids</u>: This dataset may be used to communicate the flood frequency that exists when levee first starts to provide flood protection.*
- *<u>Water Surface or Depth Grids Based Upon Additional Flood Frequencies</u>: In addition to the standard flood frequencies (10%, 4%, 2%, 1% and 0.2%) this dataset is provided when additional flood frequencies are calculated, such as a 20-percent-annual-chance (5-year), or 0.5-percent- annual-chance (200-year) event.*
- *<u>Annualized Depth Grids</u>: This dataset would communicate potential annualized losses derived from the standard flood frequency data that will normally be created as part of a new or revised flood hazard study. As indicated above, those flood frequencies are 10%, 4%, 2%, 1% and 0.2% annual chance events.*

These depth grids form the basis for refined HAZUS loss estimates (as presented in a table in Section 3 of this report) and are used to calculate potential flood losses for display on the Flood Risk Map and for tabular presentation in the FRR. *For smaller projects (such as levee areas) the depth grids may also be displayed on the Flood Risk Map to assist with site specific risk visualization.* Depth grids may also be used for a variety of ad-hoc risk visualization and risk mitigation initiatives.

HAZUS-MH is a loss estimation methodology developed by FEMA for the flood, wind, and earthquake hazards. The methodology and data established by HAZUS can also be used to study other hazards.

2.2.3 HAZUS Estimated Loss Information

Flood loss estimates provided in the FRR were developed using a FEMA flood risk assessment tool, HAZUS-MH. HAZUS, originally developed for earthquake risk assessment, has evolved into a multi-hazard tool developed and distributed by FEMA that can provide risk assessment information for floods, earthquakes, and hurricane winds. HAZUS-MH is a nationally accepted, consistent flood risk assessment tool to assist individuals and communities to create a more accurate picture of flood risk. Some benefits of using HAZUS-MH include:

- Outputs that can enhance state and local mitigation plans and help screening for cost-effectiveness in FEMA mitigation grant programs

HAZUS estimated loss data can be used in many ways to support local decision making and explaining flood risk. For mitigation planning purposes, loss data can be used to help meet requirements to develop loss information for the hazard of flood. Also, the FRM can show where flood risk varies by geographic location. For emergency management, HAZUS data can help forecast losses based on predicted events and the assignment of resources can be made accordingly. Loss information can support floodplain management efforts, including those to adopt higher regulatory standards. *Also, awareness of exposed essential facilities and infrastructure encourages mitigation actions to protect citizens from service disruption should flooding occur*.

HAZUS estimated loss data is summarized in the FRR and on the FRM, and stored in the FRD.

- Allows analysis refinement though updating inventory data, and integrating data produced using other flood models
- Widely available support documents and networks (HAZUS Users Groups or HUGs)

Files from the FRD can be imported into HAZUS-MH to develop other risk assessment information including:

- Debris generated after a flood event
- Dollar exposure of the agricultural products in a study region
- Exposure of the utility systems in the region
- Exposure of vehicles in the study region
- Damages and functionality of lifelines such as highway and rail bridges, potable water, and wastewater facilities

The FRR primarily uses specific flood risk analysis methods which are summarized below:

Scenario Loss Estimates: Scenario losses have been generated by HAZUS for four events: 10%, 2%, 1% and 0.2%. In the FRR, these losses are expressed in dollar amounts and are provided for the project study area only, even though results are shown watershed wide and at the local jurisdiction level.

Loss estimates are based on best available data, and the methodologies applied result in an approximation of risk. These estimates should be used to understand relative risk from flood and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, demographics, or economic parameters). Flood loss estimates are being provided at the project and at the community level for multiple flood frequencies including:

- Residential Asset Loss – These include direct building losses (estimated costs to repair or replace the damage caused to the building) for all classes of residential structures including single family, multi-family, manufactured housing, group housing, and nursing homes. This value also includes content losses.
- Commercial Asset Loss – These include direct building losses for all classes of commercial buildings including retail, wholesale, repair, professional services, banks, hospitals, entertainment, and parking facilities. This value also includes content and inventory losses.
- Other Asset Loss – This includes losses for facilities categorized as industrial, agricultural, religious, government, and educational . This value also includes content and inventory losses.

- *Essential Facility Losses — Essential facilities are defined in HAZUS-MH as facilities which provide services to the community and should be functional after a flood, including schools, police stations, fire stations, medical facilities, and emergency operation centers. These facilities would otherwise be considered critical facilities for mitigation planning purposes. Estimated damages (in terms of loss of function) for essential facilities are determined on a site-specific basis based on latitude and longitude. For this report, HAZUS calculates the types and numbers* of *essential facilities impacted.*
- *Infrastructure – For analysis of infrastructure*, *HAZUS-MH supports the analysis of transportation systems and lifeline utility systems. Transportation systems include highways, railways, light railway, bus, ports and harbors, ferries*, *and airport systems. Utility systems include potable water systems, wastewater, oil, natural gas, electric power, and communication systems. For this report, HAZUS calculates the types of infrastructure impacted*..
- Business Disruption – The losses associated with the inability to operate a business because of the damage sustained during the flood. Losses include inventory losses, relocation costs, income losses, rental income losses, wage losses, and direct output losses.
- Annualized Losses –Annualized losses are calculated using HAZUS-MH by taking losses from multiple events over different frequencies and expressing the long term average by year. This factors in historic patterns of frequent smaller floods with infrequent but larger events to provide a balanced presentation of flood damage.

Loss Ratio: The loss ratio expresses the scenario losses divided by the total building value for a local jurisdiction and can be a gage to determine overall community resilience as a result of a scenario event. For example, a loss ratio of 5% for a given scenario would indicate that a local jurisdiction would be more resilient and recover easier from a given event versus a loss ratio of 75% which would indicate widespread losses. *Annualized loss ratio* uses the annualized loss data as a basis for computing the ratio. Loss ratios are not computed for business disruption. These data are presented in the FRR.

HAZUS Flood Risk Value: On the FRM, flood risk is expressed the following five categories: very low, low, medium, high, and very high for census blocks that have flood risk. It is based on the 1% annual chance total asset loss by census block.

2.2.3 Areas of Mitigation Interest (AoMI)

Many factors contribute to flooding and flood losses. Some are natural, some are not. In response to these risks there has been a focus by the Federal Government, State agencies, and local jurisdictions to mitigate properties against the impacts of flood hazards so that future losses and impacts can be reduced. AoMIs are important to define more comprehensive picture of flood risk and mitigation activity in a watershed, identifying target areas and potential *projects for flood hazard mitigation, encouraging local collaboration, and communicating how various mitigation activities can successfully reduce flood risk.*

The FRR and FRM focus on identifying AoMIs that may be contributing (positively or negatively) on flooding and flood losses in the study area. AoMIs are identified through revised hydrologic and hydraulic and/or coastal analyses, other studies, or previous flood studies; community supplied data from mitigation plans, floodplain management plans, and local surveys; and the mining of Federal government databases (e.g., flood claims, disaster grants, and data from other agencies). Below is a list of the types of AoMIs that may be located in the project area.

<u>Dams</u>

A dam is a barrier built across a waterway for impounding water. Dams vary impoundments that are hundreds of feet tall and contain thousands of acre-feet of water (e.g., Hoover Dam) to small dams that are a few feet high and contain only a few acre-feet of water (e.g., small residential pond). "Dry dams", which are designed to contain water only during floods and do not impound water except for the purposes of flood control, include otherwise dry land behind the dam.

Dams vary in size and shape, the amount of water they impound, and the hazard classification they have been assigned.

While most modern large dams are highly engineered structures with components such as impervious cores and emergency spillways, most smaller and older dams are not. State dam safety programs emerged in the 1960s and it wasn't until 1979 that the first Federal Guidelines for Dam Safety were prepared. By this time, the vast majority of dams in the United States had already been constructed.

Why is a dam an Area of Mitigation Interest?

- *Many older dams were not built to any particular standard and thus may not withstand extreme rainfall events. Older dams in some parts of the country were made out of an assortment of materials. These structures may not have any capacity to release water and have the risk of being overtopped which could result in catastrophic failure.*
- *Even dams that follow current dam safety programs may not be regulated as downstream risk may have changed since the dam was constructed. Years after being built, a house, subdivision, or other development may be put in the area downstream of the dam where a possible dam failure could result in damage. Since these dams are not regulated, it is impossible to predict how safe they are.*
- *A significant dam failure risk is structural deficiencies associated with older dams that are not being adequately addressed today through needed inspection/ maintenance practices*
- *For larger dams that were constructed in the past, a flood easement may have been obtained on a property; however, since that time the construction*

This dam failure caused flooding that damaged several homes and vehicles.

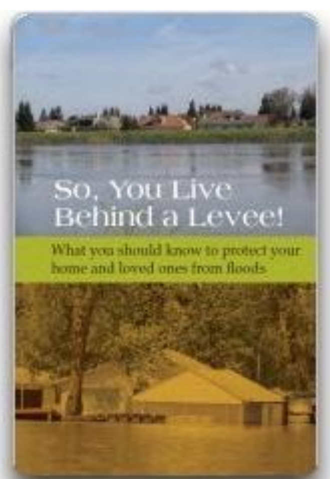
- *of buildings, though not allowed, were constructed anyway. These buildings were usually constructed in violation of the flood easement.*
- *When a new dam is constructed, the placement of such a large volume of material in a floodplain area (if that is the dam location) will displace flood waters and can alter how the watercourse flows. This can result in flooding upstream, downstream, or both.*
- *For many dams, the dam failure inundation zone is not known. This is the area that would be flooded if the dam failed and the impoundment behind the dam drained. Not having knowledge of these risk areas could lead to unprotected development in these zones. Also, for the larger federal dams that do have inundation mapping, it is frequently restricted to "For Official Use Only" and not made available to the public do to terrorism concerns*

<u>*Levees and Significant Levee-Like Structures (Embankments)*</u>
FEMA defines a levee as "a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding." Levees are sometimes referred to as dikes. Soil used to construct a levee is compacted to make the levee as strong and stable as possible. To protect against erosion and scouring, levees can be covered with everything from grass and gravel to harder surfaces like stone (riprap), asphalt, or concrete.

Similar to dams, levees have not been regulated in terms of safety and design standards until relatively recently. Many older levees were constructed in a variety of ways, from a farmer piling dirt along a stream to prevent nuisance flooding to levees made out of old mining spoil material. As engineered structures, levees are designed to a certain height and can fail if a flood event is greater than anticipated.

A floodwall is a vertical wall that is built to provide protection from a flood in a similar manner as a levee. Typically made of concrete or steel, floodwalls often are erected in urban locations where there is not enough room for a levee. Floodwalls are sometimes constructed on a levee crown to increase the levee's height.

Most new dams and levees are engineered to a certain design standard – if that design is exceeded, they could be overtopped and fail catastrophically causing more damage than if the levee wasn't there in the first place. Few levees anywhere in the nation are built to more than a 1-percent-annual-chance flood protection rating, and the areas behind them are still at some risk for flooding. This threat is called residual risk. In some states, residual risk areas can extend up to 15 miles from a riverbank. Although the probability of flooding may be lower because a levee exists, risk is nonetheless still present. The American Society of Civil Engineers' publication "So You Live Behind a Levee!" provides an in-depth explanation of levee and residual risk.



For more information about the risks associated with living behind levees, consult the publication "So You Live Behind a Levee!" published by the American Society of Civil Engineers at http://content.asce.org/ASCELeveeGuide.html

Canal levee breaches as a result of Hurricane Katrina in New Orleans in 2005. Note damages can be more extensive due to high velocity flood flows versus if the levee wasn't there.

Major embankments, on the other hand, are rarely designed with any flood protection level in mind. Railroads, road abutments, and canals – especially in the Western United States – are not considered levees or dams and have issues such as unknown construction materials/methods, and are not regulated from a flood risk standpoint.

How can levees and major embankments contribute to flooding and flood losses?

- *Like dams, many levees in the United States were constructed using unknown techniques and materials. These levees have a higher failure rate than those that have been designed to today's standards.*
- *A levee might not provide the flood risk reduction it once did as a result of flood risk changes over time. Flood risk can change due to a number of factors, including: increased flood levels due to climate change or better estimates of flooding, development in the watershed increasing flood levels and settlement of the levee or floodwall, and sedimentation in the levee channel. Increased flood levels mean decreased flood protection. The lack of adequate maintenance over time will also reduce the capability of a levee to contain the flood levels it was originally designed for.*
- *Given enough time, any levee will eventually be overtopped or damaged by a flood that exceeds the levee's capacity. Still there is a widespread public perception of levees is that they will always provide protection. This perception may lead to not taking mitigation actions such as purchasing flood insurance..*
- *A levee is a system that can fail due to its weakest point, therefore maintenance is critical. Many levees in the United States are poorly maintained or not maintained at all. Maintenance also includes maintaining the drainage systems behind the levees so they can keep the protected area dry.*

Severe beach erosion and damage resulting from a nor'easter.

<u>Coastal Structures</u>
Coastal structures are used to "harden" the shoreline for a variety of purposes and include:

- *Jetties - Structures constructed to direct currents or accommodate vessels*
- *Groyne - Protective structures of stone or concrete that extend from shore into the water to prevent a beach from washing away*
- *Sea walls - A form of hard and strong coastal defense constructed on the inland part of a coast to reduce the effects of strong waves*
- *Other coastal structures*

As the rate of sea-level rise accelerates, an increase in coastal erosion is likely. We are now facing rapid sea-level changes on a scale of decades. Higher sea levels could affect the coastal zone and accelerate coastal erosion and flooding in a variety of ways, including greater shoreline retreat, increased coastal erosion rates, property destruction, and saltwater intrusion into bays, rivers, and *underground water resources. In addition, a general elevation in the water table due to sea-level rise will result.*

How can coastal structures contribute to flooding and flood losses?

- *While coastal structures or "hardening of the shoreline" may provide a temporary level of flood reduction for a very specific site, it also interrupts the dynamic processes of the littoral flow (flow along the coastline) which results in accelerated coastal erosion.*
- *Erosion often occurs along beaches during storms, especially severe storms that stay offshore for days and result in ongoing battering of the shoreline through high wind and waves. As the beach erodes, vulnerable properties are placed at even greater risk to coastal flooding, storm surge, wave heights, wave run up, and coastal erosion.*
- *Higher water tables associated with sea level rise could lead to the failure of septic systems and other drainage systems, such as storm drains, which need to be located at a certain elevation above the water table. Elevation of the water table would also affect the river drainage systems by affecting the rate of infiltration and increase the amount of runoff which would, in turn, increase the risk of flooding.*

Stream Flow Pinch Points

A flow pinch point occurs when a human made structure such as a culvert or bridge constricts the flow of a river or stream. The results of this constriction can be increased damage potential to the structure, an increase in velocity of flow through the structure, and the creation of significant ponding or backwater upstream of the structure. Regulatory standards regarding the proper opening size for a structure spanning a river or stream are not consistent and may be non-existent. Some local regulations require structures to pass a volume of water that corresponds to a certain size rain event; however, under sizing these openings can result in flood damage to the structure itself. After a large flood event, it is not uncommon to have numerous bridges and culverts "washed out."

How can stream flow pinch points contribute to flooding and flood losses?

- *Flow pinch points can back water up on property upstream of the structure if not designed properly.*
- *These structures can accelerate the flow through the structure causing downstream erosion if not properly mitigated. This erosion can affect the structure itself, causing undermining and failure.*
- *If the pinch point is a bridge or culvert, it can get washed out causing an area to become isolated and potentially more difficult to evacuate.*
- *Washed-out culverts and associated debris can wash downstream and cause the next pinch point to fail.*

High Risk Essential Facilities

Essential facilities, or sometimes called "critical facilities", are those whose impairment during a flood could cause significant problems to individuals or communities. For example, when a community's wastewater treatment is flooded and shut down, not only do contaminants escape and flow into the floodwaters, but backflows of sewage can contaminate basements or other areas of the community. Similarly, when a facility such as a hospital is flooded, it can result in a significant hardship on the community not only during the event but long afterwards as well.

How can high risk essential facilities contribute to flooding and flood losses?

- *Costly and specialized equipment may be damaged and need to be replaced.*
- *Impairments to facilities such as fire stations may result in lengthy delays in responding and a focus on evacuating the facility itself.*
- *Critical records and information stored at these facilities may be lost.*

Clusters of past flood insurance claims can show where there is a repetitive flood problem.

<u>Past Flood Insurance Claims, and Individual Assistance/Public Assistance Hotspots</u>
Assistance provided after flood events (flood insurance in any event, and Individual Assistance (IA) or Public Assistance (PA) after declared disasters) occurs in flood affected areas. Understanding geographically where this assistance is being provided may indicate unique flood problems.

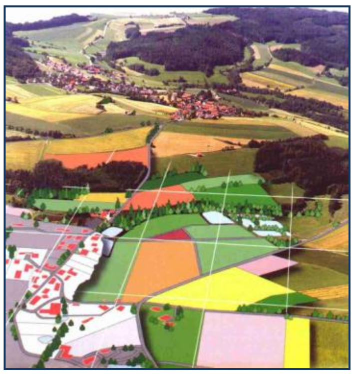
Flood insurance claims are not always equally distributed in a community. Although estimates indicate that 20 to 50 percent of structures in identified flood hazard areas have flood insurance, clusters of past claims may indicate where there is a flood problem. However, clusters of past claims and/or areas where there are high payments under FEMA's Individual Assistance(IA) or Public Assistance (PA) Programs may indicate areas of significant flood hazard.

Why are past claim hot spots areas of mitigation interest?

- *A past claim hotspot may reflect an area of recent construction (large numbers of flood insurance policies as a result of a large number of mortgages), and an area where the as-built construction is not in accordance with local floodplain management regulations. Sometimes clusters of past claims occur in subdivisions that were constructed before flood protection standards were in place, places with inadequate stormwater management systems, or in areas that may not have been identified as SFHAs.*
- *Clusters of IA or PA claims may indicate areas where high flood insurance coverage or other mitigation actions are needed.*

<u>Significant Land Use Changes</u>
Recent or proposed development in SFHAs must be carefully evaluated to ensure that no adverse impacts occur as a result. Development, whether it is a 100-lot subdivision or a single lot big box commercial outlet, can result in large amounts

Rooftops, pavement, patios, and driveways contribute to the impervious area in a watershed.



of fill and other material being deposited in flood storage areas. Development in flood hazard areas is only protected to a certain standard – floods that exceed those standards will damage the developed areas. Development also includes all necessary infrastructure and services to maintain that development over time.

One of the factors that contributes to flooding in a watershed is the amount of ground that is available to absorb water. When development occurs, hard surfaces such as rooftops, pavement, patios, and driveways do not allow water to absorb into the ground and more of the rainwater becomes runoff flowing directly into streams and drainage ways. As a result, the "peak flow" in a stream or drainage way after a storm event will be higher and occur faster. Without careful planning, major land use changes can affect the impervious area of a site and result in a significant increase in flood risk.

Sometimes a major land use change may be for planning purposes only. For example a land use change that rezones land from a classification such as floodplain that restricts development to a zone such as industrial or high density residential could result in significant new infrastructure and structures in high flood risk areas.

How can past or planned major land use changes in SFHAs contribute to flooding and flood losses?

- Development in areas mapped SFHAs reduces flood storage areas, which can make flooding worse at the development site and downstream of it.
- Impervious surfaces speed up the water flowing in the streams, which can increase erosion and the danger that fast-flowing floodwaters pose to people and buildings.
- Rezoning flood prone areas to high densities and/or higher intensity uses can result in more people and property at risk of flooding and flood damage.

Key Emergency Routes Overtopped During Frequent Flooding Events

Roads are not always designed to flood protection levels. In fact, many major roadways including interstate highways, US highways, and state routes are chronically flooded. When an alternative route is available, inconvenience, and minor losses result. However, when no or lengthy alternate routes are available, when the road being overtopped conveys more traffic than alternate routes, or that is a large economic driver (i.e., industrial park), overtopping can result in significant economic losses as well as impact public safety.

When large highway close due to flooding, traffic is detoured causing inconvenience and economic loss

Why are overtopped roads areas of mitigation interest?

- Such areas, when identified can be accounted for and incorporated into evacuation and other operational plans.
- Overtopped roads can sometimes be elevated or reinforced to reduce the overtopping.

Drainage or Stormwater Based Flood Hazard Areas, or Areas not Identified as Floodprone on the FIRM but known to be Inundated

Flood hazard areas exist everywhere. While FEMA maps many of these, there are others not identified. Many of these areas may be located in communities with existing, older, and often inadequate stormwater management systems or in very rural areas. Other similar areas could be a result of complex or unique drainage characteristics. Even though they are not mapped, awareness of these areas is important so adequate planning and mitigation actions can be performed.

Why are drainage or stormwater based flood hazard areas or unidentified floodprone locations areas of mitigation interest?

- *So further investigation of such areas can occur and based on scientific data, appropriate mitigation actions can result (i.e., land use and building standards).*
- *To create viable mitigation project applications in order to reduce flood losses.*

Areas of Mitigation Success

Flood mitigation projects are powerful tools to communicate the concepts of mitigation and result in more resilient communities. Flood hazard mitigation actions have been occurring for decades and by multiple agencies. Both structural measures – those that result in flood control structures and non-structural measures have been implemented in thousands of communities. An extensive list of mitigation actions can be found in Section 4.

Why are areas of mitigation success areas of mitigation interest?

- *Mitigation successes identify those areas within the community that have experienced a reduction or elimination of flood risk*
- *Such areas are essential in demonstrating successful loss reduction measures and in educating citizens and officials on available flood hazard mitigation techniques.*
- *Avoided losses can be calculated and shown.*
- *Demonstrate successful techniques that can be implemented by individuals and communities.*

The Flood Risk Map (FRM) provides a graphical overview of the study area which highlights areas of risk that should be noted, based on potential losses, exposed facilities etc. based on data found in the FRD. Refer to the data in the FRD to conduct additional analyses.

3. Flood Risk Analysis Results

The following pages provide the results of detailed analyses for the study area as a whole and for each community within the project area. Each summary includes the following:

- FRM: The Flood Risk Map illustrates the study area base data reflecting community boundaries, major roads, and stream lines; potential losses that include both the 2010 Flood AAL study supplemented with new HAZUS-MH runs for areas with new or updated flood modeling; new study areas; a bar chart summarizing community per capita loss; and provides graphics and text that promotes access and usage of additional data available thru the FRD, FIRM, National Flood Hazard Layer and viewers (desktop or FEMA website, etc.). This information can be used to assist in watershed level planning as well as for developing mitigation actions within each jurisdiction located within the watershed.

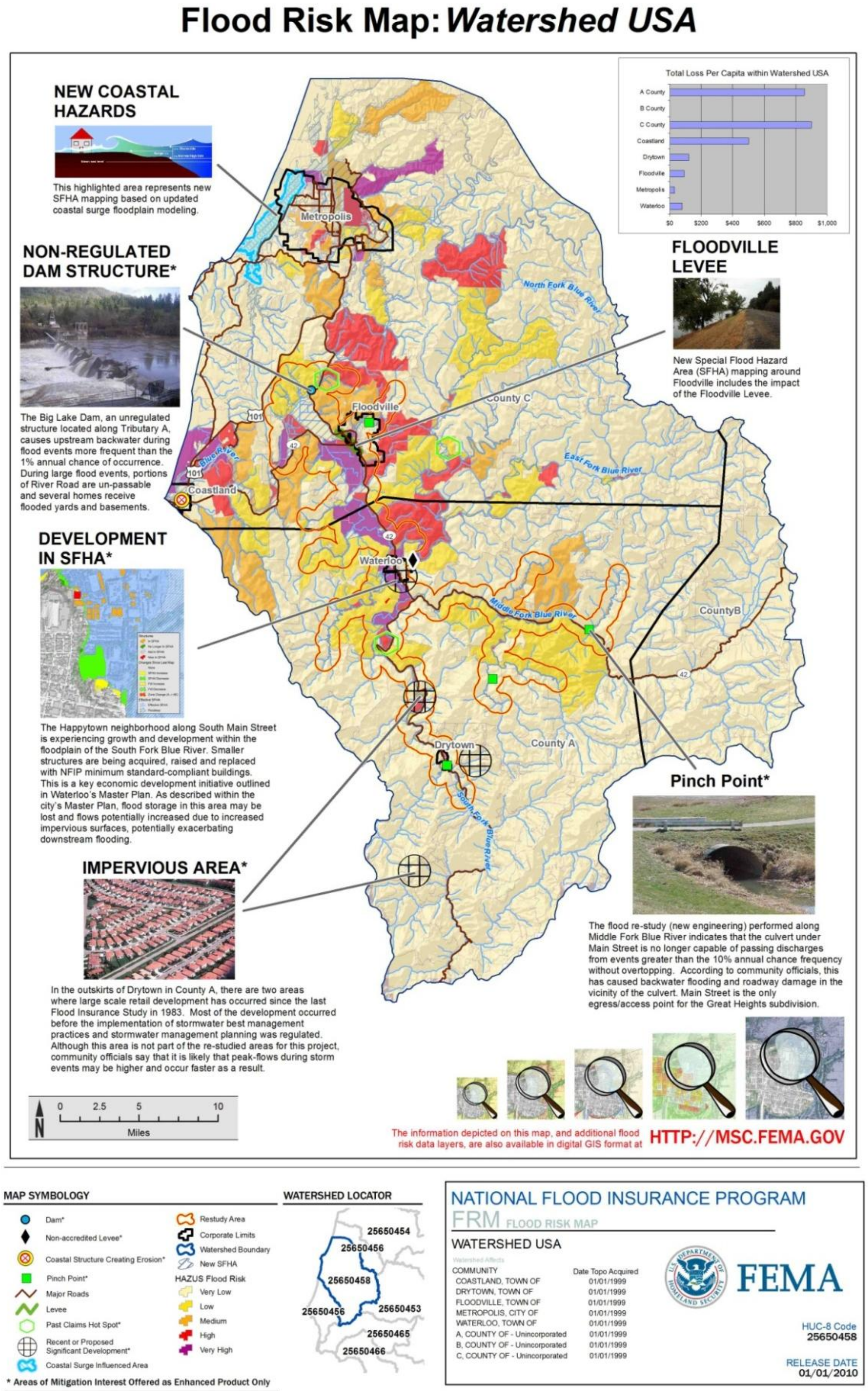
- Study Area summary:

    - Changes Since Last FIRM: A summary of where the floodplain and flood zones have increased or decreased (only analyzed for areas that were previously mapped using digital FIRMs). Flood Depth and Analysis Grids: A general discussion of the data provided in the FRD.
    - Flood Risk Analysis: A loss estimation of potential flood damages by using different flood scenarios.
    - *Areas o f Mitigation Interest: A description of areas that may require mitigation or additional risk analysis.*

- Community summary (for each community, representing the portion of the community in the study area):

    - Changes Since Last FIRM: A summary of where the floodplain and flood zones have increased or decreased (only analyzed for areas that were previously mapped using digital FIRMs).
    - Flood Depth and Analysis Grids: A general discussion of the data provided in the FRD.
    - Flood Risk Analysis: A loss estimation of potential flood damages by using different flood scenarios.
    - *Areas o f Mitigation Interest: A description of areas that may require mitigation or additional risk analysis.*

3.1 Flood Risk Map



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3.1 Watershed USA Summary

Overview

Watershed USA, located in (insert state), includes the following communities:

Community Name	CID	Total Community Population	Percent of Population in Watershed	Total Community Land Area (sq mi)	Percent of Land Area in Watershed
Village of Coastland	0123465	555	24	.7	30
Village of Drytown	0123475	1,232	10	1.4	15
City of Floodville	0123456	22,784	30	8	25
City of Metropolis	0124386	12,444	100	8.5	100
Town of Waterloo	0123468	3,633	100	3.3	100
County A	0123471	112,541	44	300	50
County B	0123482	66,320	30	205	33
County C	0123485	21,998	5	40	20

Community-specific results are provided on subsequent pages. Data provided below and on subsequent pages only includes areas located within the Watershed USA study area and do not necessarily represent community-wide totals.

The information below provides an overview of floodplain management program information for the study area of Watershed USA as of the date of this publication.

- All communities participate in the National Flood Insurance Program (NFIP)
- Village of Drytown, City of Floodville, City of Metropolis participate in the NFIP Community Rating System (CRS)
- All jurisdictions participate in FEMA-approved hazard mitigation plans
- Past Federal Disaster Declarations for flooding =36
- NFIP Policy Coverage (policies/value)= 18,260 policies totaling approximately $89,890,000
- NFIP-recognized repetitive loss properties = 35 (25 residential and 10 commercial)
- NFIP-recognized Severe Repetitive Loss properties =18 (all residential)

Section 2 of the Watershed USA Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Appendix C and are found in the Flood Risk Database (FRD).

Changes Since Last FIRM

Special Flood Hazard Area (SFHA) boundaries within Watershed USA were updated due to new engineering analysis performed within the study area. The updated modeling produced new flood zone areas and new base flood elevations in some areas, and leveraged recently developed LiDAR-based topographic data for the study area. The table below summarizes the increases, decreases, and net change of SFHAs for the watershed.

Area of Interest	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Area within SFHA	21.1	1.0	-2.5	-1.5
Area within Floodway	3.2	0.7	-0.1	3.0

Section 2 of the FRR provides more information regarding the source and methodology used to develop this table.

Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. During this Risk MAP project, FEMA confirmed several areas within this watershed as having mitigation potential and encourages the communities within the watershed to continue working with the State Hazard Mitigation

Officer to further identify and mitigate these high risk areas and structures. Specific areas within each jurisdiction are detailed within the individual community summaries.

Flood Depth and Analysis Grids

The FRD contains datasets in the form of depth grids for the entire study area that can be used for additional analysis, enhanced visualization, and communication of flood risks for hazard mitigation planning and emergency management. The data provided within the FRD should be used to further isolate areas where flood mitigation potential is high, and may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water should seriously consider mitigation options for implementation. Section 2 of the FRR provides general information regarding the development of and potential uses for this data.

HAZUS-MH Estimated Loss Information

Watershed USA's flood risk analysis incorporates results from a FEMA performed HAZUS-MH analysis which accounts for newly modeled areas in the study area and newly modeled depths for certain flood events. Potential losses were estimated as well as potential loss ratios for multiple scenarios. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

			Estimated Potential Losses for Flood Event Scenarios									
	Total Inventory		10% (10-yr)		2% (50-yr)		1% (100-yr)		0.2% (500-yr)		Annualized ($/yr)	
	Estimated Value	Percent of Total	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio
Residential Building/Contents	$94,495,000	77%	$10,439,000	11%	$13,571,000	14%	$19,273,000	20%	$32,925,000	35%	$176,000	0%
Commercial Building/Contents	$15,127,000	12%	$2,112,000	14%	$3,225,000	21%	$4,337,000	29%	$4,925,000	33%	$109,000	1%
Other Building/Contents	$13,073,000	11%	$1,660,000	13%	$2,195,000	17%	$3,620,000	28%	$5,430,000	42%	$79,000	1%
Total Building/Contents	**$122,695,000**	**100%**	**$14,211,000**	**12%**	**$18,991,000**	**15%**	**$27,230,000**	**22%**	**$43,280,000**	**35%**	**$364,000**	**0%**
Business Disruption	**N/A**	**N/A**	**$760,000**	**N/A**	**$1,259,000**	**N/A**	**$2,011,000**	**N/A**	**$4,074,000**	**N/A**	**$18,000**	**N/A**
TOTAL	**$122,695,000**	**N/A**	**$14,971,000**	**N/A**	**$20,250,000**	**N/A**	**$29,241,000**	**N/A**	**$47,354,000**	**N/A**	**$382,000**	**N/A**

Source: HAZUS-MH analysis using local tax data and Risk MAP depth grids
[1] Total Building/Content Losses = Residential Building/Content Loss + Commercial Building/Content Loss + Other Building/Content Loss.
[2] Loss ratio = Dollar Losses / Estimated Value. Loss ratios are computed using actual loss and value numbers from HAZUS, not rounded numbers.
[3] Losses are rounded to the nearest thousand and loss ratios are rounded to the nearest whole number.

3.2 Village of Coastland Summary (CID 0123465)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.3 Village of Drytown Summary (CID 0123475)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.4 City of Floodville Summary (CID 0123456)

Overview

The City of Floodville is the largest of five cities located within County A. The information below provides an overview of the community's floodplain management program information as of the date of this publication.

- Participating in National Flood Insurance Program (NFIP)
- Participating in NFIP Community Rating System (CRS)
- Participating in the County A Multi-Hazard Mitigation Plan which expires 10/01/2012
- Past Federal Disaster Declarations for flooding = 5
- NFIP Policy Coverage (policies/value) = 2,270 policies totaling approximately $9,980,000
- NFIP-recognized repetitive loss properties = 17 (11 residential and 6 commercial)
- NFIP-recognized Severe Repetitive Loss properties = 4 (residential)

Data provided below only includes areas within the City of Floodville that area located within the Watershed USA study area and do not necessarily represent community-wide totals. Section 2 of the Watershed USA Flood Risk Report (FRR) provides more information regarding the source and methodology used to develop the information presented below. Datasets used toward the generation of results of this project are described in Appendix C and are found in the Flood Risk Database (FRD).

Changes Since Last FIRM

Special Flood Hazard Area (SFHA) boundaries within the City of Floodville were updated due to new engineering analysis performed on Spartan Creek. The updated modeling produced new flood zone areas and new base flood elevations, and leveraged the City's recently developed LiDAR-based topographic data. The table below summarizes the increases, decreases, and net change of SFHAs for the community. Also, population and building data was provided by the City Of Floodville which was used to analyze changes in numbers of persons and buildings in areas of change. Areas with the greatest increase in flood zone area are located south of the city. Areas with the most decrease in flood zone area are located near the city's northern boundary.

Areas of Change	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)	*Net Population*	*Incr Population*	*Incr Bldgs*	*Decr Population*	*Decr Bldgs*
Area within SFHA	2.5	0.1	-0.3	-0.1	*-15*	*215*	*72*	*-230*	-78
Area within Floodway	0.3	0.1	-0.0	0.3	*10*	*12*	*5*	*-2*	*-2*

Previous FIRM effective Date: September 10, 2004
Current FIRM effective Date: October 29, 2010

Flood Depth and Analysis Grids

See the FRD for the following depth and analysis grid data (Section 2 of the FRR provides general information regarding the development of and potential uses for this data):

- Multi-frequency Flood Depth grids (10%, 4%, 2%, 1%, and 0.2% annual chance)
- Percent annual chance of flooding grid
- Percent chance of flooding over a 30-year period grid
- *Water Surface Elevation grids (10%, 4%, 2%, 1%, and 0.2% annual chance)*
- *Water Surface Elevation Change Grid*
- *1% Plus Flood Depth Grids*
- *Velocity grids*
- *Top and toe of levee depth grids*

- *Water surface or depth grids based upon additional flood frequency profiles*

Additional information and data layers provided within the FRD should be used to further isolate these and other areas where flood mitigation potential is high, and includes data which may be helpful in planning and implementing mitigation strategies. Properties located in areas expected to experience some depth of water should seriously consider mitigation options for implementation.

HAZUS-MH Estimated Loss Information

The City of Floodville's flood risk analysis uses results from a FEMA performed HAZUS-MH analysis which accounts for newly modeled areas in the study area, and newly modeled depths for certain flood events. *Potential losses were compared with locally provided tax data to estimate loss ratios for multiple scenarios*. Additional information and data layers provided within the FRD should be used to further analyze potential losses and areas where they are likely to occur.

			Estimated Potential Losses for Flood Event Scenarios									
	Total Inventory		10% (10-yr)		2% (50-yr)		1% (100-yr)		0.2% (500-yr)		Annualized ($/yr)	
	Estimated Value	Percent of Total	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio	Dollar Losses	Loss Ratio
Residential Building/Contents	$17,200,000	78%	$1,300,000	7%	$1,600,000	10%	$2,300,000	14%	$4,000,000	23%	$30,000	0%
Commercial Building/Contents	$1,100,000	5%	$40,000	3%	$60,000	5%	$100,000	11%	$300,000	22%	$20,000	1%
Other Building/Contents	$3,700,000	17%	$20,000	1%	$70,000	2%	$100,000	3%	$200,000	6%	$0	0%
Total Building/Contents	**$22,000,000**	**100%**	**$1,360,000**	**6%**	**$1,730,000**	**8%**	**$2,500,000**	**12%**	**$4,500,000**	**20%**	**$50,000**	**0%**
Business Disruption	**N/A**	**N/A**	**$90,000**	**N/A**	**$200,000**	**N/A**	**$200,000**	**N/A**	**$500,000**	**N/A**	**$0**	**N/A**
TOTAL	**$22,000,000**	**N/A**	**$1,450,000**	**N/A**	**$1,930,000**	**N/A**	**$2,700,000**	**N/A**	**$5,000,000**	**N/A**	**$50,000**	**N/A**

Source: HAZUS-MH analysis using local tax data and Risk MAP depth grids
[1]Total Building/Content Losses = Residential Building/Content Loss + Commercial Building/Content Loss + Other Building/Content Loss.
[2] Loss ratio = Dollar Losses / Estimated Value. Loss ratios are computed using actual loss and value numbers from HAZUS, not rounded numbers.
[3] Losses are rounded to the nearest thousand and loss ratios are rounded to the nearest whole number.

Areas of Mitigation Interest

Section 2.2.3 of the FRR provides more information regarding area of mitigation interest, how they are defined for this analysis, and potential mitigation actions that could be considered for each type. The table below summarizes the number of areas of mitigation interest by type.

Type of Mitigation Interest	*Number of Areas*	*Data Source*
Dam	*1*	*State CTP*
Levee	*2*	*State CTP*
Stream Flow Pinch Points	*2*	*Local Pub Works, engineering models*
Significant Land Use Changes	*1*	*Local Planning Div*
Past Claims Hot Spot	*1*	*State NFIP*
Area of Mitigation Success	*2*	*State SHMO*

Many areas of mitigation interest were identified for the City of Floodville. A significant factor for the Big Vista district is pinched flow on Spartan Creek at the Parson Street bridge. It should also be noted that the Shady Tree subdivision was previously mapped outside of the SFHA as a provisionally accredited levee zone. The levee has since been de-accredited due to freeboard limitations subjecting the neighborhood to increased flood risk and resulting in expanded flood zone mapping.

Other areas of mitigation interest include the Pike dam, which is a high hazard dam located downstream of the Indian River. Approximately 450 structures are located immediately below this dam that could face additional risk should the dam fail. Refer to the County A Multi-Hazard Mitigation Plan for additional information regarding this structure, its area of potential *impact and its past performance during major storm events. At an intersection between New York canal and Indian Creek, the assumption was the gates on the canal were going to control flow to the canal capacity. The gates on the canal no longer work, allowing more water which exceeds the canal's capacity to handle excess flow. Therefore, an assumption was made for the study that the canal would fail and the entire flow would have to enter Indian Creek, increasing the flow by 1,500 cubic feet per second (cfs) and expanding the floodplain.*

Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. One indicator is claims through the NFIP. While most of the city's flood claims (240 out of 268) have originated from the Big Vista district, the Highway 42 corridor is home to several others including three repetitive loss properties and one severe repetitive loss property. Most of the claims are located near the confluence of the Indian River and Spartan Creek, producing over $18 million in claims within the last 10 years.

According to the City of Floodville Annex of the County A Multi-Hazard Mitigation Plan, the City has identified 14 mitigation projects for this area and to date only two have been implemented. During this Risk MAP project, FEMA confirmed this area as having mitigation potential and encouraged the community to continue working with the State Hazard Mitigation Officer to further identify and mitigate these high risk areas and structures.

3.5 City of Metropolis Summary (CID 0124386)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.6 Town of Waterloo Summary (CID 0123468)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.7 County A Summary (CID 0123471)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.8 **County B Summary** (CID 0123482)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

3.9 **County C Summary** (CID 0123485)

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Refer to the City of Floodville Summary (Section 3.4) for a model representation of the proposed summary format.

Before Mitigation and After Mitigation

Communities will need to prioritize projects as part of the planning process. FEMA can then help route federal mitigation dollars to fund these projects.

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: To reduce flood losses, to facilitate accurate insurance rating; and to promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount).

4. Actions to Reduce Flood Risk

4.1 Types of Mitigation Actions

Mitigation provides a critical foundation on which to reduce loss of life and property by avoiding or lessening the impact of hazard events. This creates safer communities, and facilitates resiliency by enabling communities to return to normal function as quickly as possible after a hazard event. Once a community understands its flood risk, it is in a better position to identify potential mitigation actions that can reduce the risk to its people and property. The mitigation plan requirements in 44 CFR Part 201 encourage communities to understand their vulnerability to hazards and take actions to minimize vulnerability and promote resilience. Flood mitigation actions generally fall into the following categories:

Preventative Measures

Preventative measures are intended to keep flood hazards from getting worse. They can reduce future vulnerability to flooding, especially in areas where development has not yet occurred or where capital improvements have not been substantial. Examples include:

- Comprehensive land use planning
- Zoning regulations
- Subdivision regulations
- Open space preservation
- Building codes
- Floodplain development regulations
- Stormwater management
- Purchase development rights or conservation easements
- Participation in the NFIP Community Rating System (CRS)

Property Protection Measures

Property protection measures protect existing buildings by modifying the building to withstand floods, or by removing buildings from hazardous locations. Examples include:

- Building relocation
- Acquisition and clearance
- Building elevation
- Barrier installation
- Building retrofit

Natural Resource Protection Activities

Natural resource protection activities reduce the impact of floods by preserving or restoring natural areas such as floodplains, wetlands, and dunes and their natural functions. Examples include:

- Wetland protection
- Habitat protection
- Erosion and sedimentation control

- Best management practices (BMPs)
- Prevention of stream dumping activities (anti-litter campaigns)
- Improved forestry practices such as reforesting or selective timbering (extraction)
-

Emergency Services (ES) Measures
Although not typically considered a mitigation technique, emergency service measures minimize the impact of flooding on people and property. These are actions commonly taken immediately prior to, during, or in response to a hazard event. Examples include:

- Hazard warning system
- Emergency response plan
- COOP and COG planning
- Critical facilities protection
- Health and safety maintenance
- Post flood recovery planning

For more information regarding hazard mitigation techniques, best practices, and potential grant funding sources, visit www.fema.gov or contact your local floodplain manager, emergency manager, or State Hazard Mitigation Officer.

Structural Mitigation Projects
Structural mitigation projects lessen the impact of floods by modifying the environmental natural progression of the flooding event. Structural protection such as upgrading dams/levees for already existing development and critical facilities may be a realistic alternative. However, citizens should be made aware of their residual risk. Examples include:

- Reservoirs, retention, and detention basins
- Levees and floodwalls
- Channel modifications
- Channel maintenance

Public Education and Awareness Activities
Public education and awareness activities advise residents, business owners, potential property buyers, and visitors about floods, hazardous areas, and mitigation techniques they can use to reduce the flood risk to themselves and their property. Examples include:

- Readily available and readable updated maps
- Outreach projects
- Library
- Technical assistance
- Real estate disclosure
- Environmental education
- Providing risk information via the nightly news

In Section 3, specific Areas of Mitigation Interest were identified. Table 4.1 below identifies possible mitigation actions for each AoMI to consider.

Table 4.1 Mitigation Actions for Areas of Mitigation Interest

AoMI	***Possible Actions to Reduce Flood Risk***
Dams	*Engineering assessment* *Dam upgrades and strengthening* *Emergency Action Plan (EAPs)* *Dam removal* *Easement creation in impoundment and downstream inundation areas*
Levees (accredited and non-accredited) and significant levee-like structures	*Generally same as dams above* *Purchase of flood insurance for at-risk structures*
Coastal Structures *Jetties* *Groins* *Seawalls* *Other structures*	*Increase coastal setbacks for construction* *Habitat restoration programs* *Wetland restoration and mitigation banking programs*
Stream Flow Pinch Point *Undersized culverts or bridge openings*	*Engineering Analysis* *Replacement of structure pre- and post-disaster*
Past Claims and IA/PA Hot Spots	*Acquisition* *Elevation* *Relocation* *Floodproofing*
Major Land Use Changes (past 5 years or next 5 years)	*Higher regulatory standards, Stormwater BMPs, Transfer of Development rights, compensatory storage and equal conveyance standards, etc.*
Key emergency routes overtopped during frequent flooding events	*Elevation* *Creation of alternate routes* *Design as low water crossing*
Areas of Significant Riverine or Coastal Erosion	*Relocation of buildings and infrastructure, regulations and planning, natural vegetation, hardening*
Drainage or Stormwater Based Flood Hazard Areas, or Areas not Identified as Floodprone on the FIRM but known to be Inundated	*Identification of all flood hazard areas*
Areas of Mitigation Success	*N/A*

4.2 Identifying Specific Actions for your Community

As many mitigation actions are possible to lessen the impact of floods, how can a community decide which ones are appropriate to implement? There are many ways to identify specific actions most appropriate for a community. Some factors to consider may include the following:

- Site characteristics – Does the site present unique challenges (e.g., significant slopes, erosion potential)?

- Flood characteristics – Are the flood waters affecting the site fast or slow moving? Is there debris associated with the flow? How deep is the flooding?

- Social acceptance – Will the mitigation action be acceptable to the public? Does it cause social or cultural problems?

- Technical feasibility – Is the mitigation action technically feasible (e.g., making a building watertight to a reasonable depth)?

- Administrative feasibility –Is there administrative capability to implement the mitigation action?

- Legal – Does the mitigation action meet all applicable codes, regulations, and laws? Public officials may have a legal responsibility to act and inform citizens if a known hazard has been identified.

- Economic — Is the mitigation action affordable? Is it eligible under grant or other funding programs? Can it be completed within existing budgets?

- Environmental – Does the mitigation action cause adverse impacts on the environment or can they be mitigated? Is it the most appropriate action among the possible alternatives?

Your local Hazard Mitigation Plan is a valuable place to identify and prioritize possible mitigation actions. The plan includes a mitigation strategy with mitigation actions that were developed through a public and open process. You can then add to or modify those actions based on what is learned during the course of the Risk MAP project and the information provided within this FRR.

Refer to FEMA Mitigation Planning How To Guide #3 (FEMA 386-3) “Developing the Mitigation Plan - identifying mitigation actions and implementation strategies” for more information on how to identify specific mitigation actions to address hazard risk in your community.

FEMA in collaboration with the American Planning Association has released the publication, “Integrating Hazard Mitigation into Local Planning.” This guide explains how hazard mitigation can be incorporated into several different types of local planning programs. For more information go to www.planning.org. or http://www.fema.gov/library.

4.3 Mitigation Programs and Assistance

Not all mitigation activities require funding (e.g., local policy actions such as strengthening a flood damage prevention ordinance), and those that do are not limited to outside funding sources (e.g. include in local capital improvements plan, etc.). For those mitigation actions that require assistance through funding or technical expertise, several State and Federal agencies have flood hazard mitigation grant programs and offer technical assistance. These programs may be funded at different levels over time or may be activated under special circumstances such as after a presidential disaster declaration.

FEMA Mitigation Programs and Assistance

FEMA awards many mitigation grants each year to States and communities to undertake mitigation projects to prevent future loss of life and property resulting from hazard impacts, including flooding. The FEMA Hazard Mitigation Assistance (HMA) programs provide grants for mitigation through the programs listed in Table 4.1 below.

Table 4.2 FEMA Hazard Mitigation Assistance Programs

Mitigation Grant Program	Authorization	Purpose
Hazard Mitigation Grant Program (HMGP)	Robert T. Stafford Disaster Relief and Emergency Assistance Act	Activated after a presidential disaster declaration; provides funds on a sliding scale formula based on a percentage of the total federal assistance for a disaster for long-term mitigation measures to reduce vulnerability to natural hazards
Flood Mitigation Assistance (FMA)	National Flood Insurance Reform Act	Reduce or eliminate claims against the NFIP
Pre-Disaster Mitigation (PDM)	Disaster Mitigation Act	National competitive program focuses on mitigation project and planning activities that address multiple natural hazards
Repetitive Flood Claims (RFC)	Bunning-Bereuter-Blumenauer Flood Insurance Reform Act	Reduce flood claims against the NFIP through flood mitigation; properties must be currently NFIP insured and have had at least one NFIP claim
Severe Repetitive Loss (SRL)	Bunning-Bereuter-Blumenauer Flood Insurance Reform Act	Reduce or eliminate the long-term risk of flood damage to SRL residential structures currently insured under the NFIP

Communities can link hazard mitigation plans and actions to the right FEMA grant programs to fund flood risk reduction. More information about FEMA HMA programs can be found at http://www.fema.gov/government/grant/hma/index.shtm.

The HMGP and PDM programs offer funding for mitigation planning and project activities that address multiple natural hazard events. The FMA, RFC, and SRL programs focus funding efforts on reducing claims against the NFIP. Funding under the HMA programs is subject to availability of annual appropriations and under HMGP to the amount of FEMA disaster recovery assistance under a presidential major disaster declaration.

The Silver Jackets program, active in several states, is a partnership of the USACE, FEMA and state agencies. The Silver Jackets program provides a state-based strategy for an interagency approach to planning and implementing measures for risk reduction.

FEMA's HMA grants are awarded to eligible States, Tribes, and Territories (Applicant) that, in turn, provide subgrants to local governments and communities (subapplicant). The Applicant selects and prioritizes subapplications developed and submitted to them by subapplicants and submits them to FEMA for consideration of funding. Prospective subapplicants should consult the office designated as their Applicant for further information regarding specific program and application requirements. Contact information for the FEMA Regional Offices and State Hazard Mitigation Officers is available on the FEMA website.

Additional Mitigation Programs and Assistance

Several additional agencies including the US Army Corps of Engineers (USACE), Natural Resource Conservation Service (NRCS), US Geological Survey (USGS), and others have specialists and a lot of information on flood hazard mitigation.

The State NFIP Coordinator and State Hazard Mitigation Officer are state level sources of information and assistance, which vary among different states.

A. Appendix A: Acronyms and Definitions

ACRONYMS

A

AAL	Average Annualized Loss
ALR	Annualized Loss Ratio

B

BCA	Benefit-Cost Analysis
BFE	Base Flood Elevation

C

CFR	Code of Federal Regulations
COG	Continuity of Government Plan
COOP	Continuity of Operations Plan
CRS	Community Rating System

D

DHS	Department of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000

E

EOP	Emergency Operations Plan

F

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FRD	Flood Risk Database
FRM	Flood Risk Map
FRR	Flood Risk Report
FY	Fiscal Year

G

GIS	Geographic Information System

H

HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program

N

NFIA	National Flood Insurance Act
NFIP	National Flood Insurance Program
NRCS	Natural Resource Conservation Service

P

PDM	Pre-Disaster Mitigation

R

RFC	Repetitive Flood Claims
Risk MAP	Mapping, Assessment, and Planning

S

SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SRL	Severe Repetitive Loss

U

USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

DEFINITIONS

1-percent-annual-chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

0.2-percent-annual-chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Average Annualized Loss (AAL) – The estimated long-term weighted average value of losses to property in any single year in a specified geographic area

Annualized Loss Ratio (ALR) – expresses the annualized loss as a fraction of the value of the local inventory (total value/annualized loss).

Base Flood Elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Berm – A small levee, typically built from fill dirt.

Cfs – Cubic feet per second, the unit by which discharges are measured (a cubic foot of water is about 7.5 gallons).

Consequence (of flood) – The estimated damages associated with a given flood occurrence.

Crest – The peak stage or elevation reached or expected to be reached by the floodwaters of a specific flood at a given location.

Dam – Any artificial barrier that impounds or diverts water and that: (1) is 25 feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of 50 acre-feet or more.

Design flood event – The greater of the following two flood events: (1) the base flood, affecting those areas identified as SFHAs on a community's FIRM; or (2) the flood corresponding to the area designated as a flood hazard area on a community's flood hazard map or otherwise legally designated.

Erosion – Process by which floodwaters lower the ground surface in an area by removing upper layers of soil.

Essential facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in HAZUS-MH, essential facilities include hospitals, emergency operations centers, police stations, fire stations and schools.

Flood – A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is your property) from: overflow of inland or tidal waters; unusual and rapid accumulation or runoff of surface waters from any source; mudflow; or collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community. See also Digital Flood Insurance Rate Map.

Flood Insurance Study (FIS) – Contains an examination, evaluation, and determination of the flood hazards of a community, and if appropriate, the corresponding water-surface elevations.

Flood risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of flooding. Sometimes referred to as vulnerability.

Floodborne debris impact – Floodwater moving at a moderate or high velocity can carry floodborne debris that can impact buildings and damage walls and foundations.

Floodwall – A long, narrow concrete or masonry wall built to protect land from flooding.

Floodway (regulatory)– The channel of a river or other watercourse and that portion of the adjacent floodplain that must remain unobstructed to permit passage of the base flood without cumulatively increasing the water surface elevation more than a designated height (usually 1 foot).

Floodway fringe – This is the portion of the SFHA that is outside of the floodway.

Flow pinch point – A point where a human-made structure constricts the flow of a river or stream.

Freeboard – The height above the base flood added to a structure to reduce the potential for flooding. The increased elevation of a building above the minimum design flood level to provide additional protection for flood levels higher than the 1-percent chance flood level and to compensate for inherent inaccuracies in flood hazard mapping.

HAZUS-MH – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds, and earthquakes.

High velocity flow – Typically comprised of floodwaters moving faster than 5 feet per second.

Loss Ratio– expresses loss as a fraction of the value of the local inventory (total value/ loss).

Levee – A manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Mudflow – A river of liquid and flowing mud on the surfaces of normally dry land areas, as when earth is carried by a current of water.

Probability (of flood) – The likelihood that a flood will occur in a given area.

Risk MAP – The vision of this FEMA strategy is to work collaboratively with State, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Special Flood Hazard Area (SFHA) – Portion of the floodplain subject to inundation by the base flood.

Stafford Act – Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, PL 93-288. This Act constitutes the statutory authority for most federal disaster response activities especially as they pertain to FEMA and FEMA programs.

Stillwater – A rise in the normal level of a water body.

Vulnerability – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of flooding. Sometimes referred to as flood risk.

B. Appendix B: Additional Resources

ASCE 7 – National design standard issued by the American Society of Civil Engineers, *Minimum Design Loads for Buildings and Other Structures*, which gives current requirements for dead, live, soil, flood, wind, snow, rain, ice, and earthquake loads, and their combinations, suitable for inclusion in building codes and other documents.

ASCE 24-05 – National design standard issued by the American Society of Civil Engineers, *Flood Resistant Design and Construction*, which outlines the requirements for flood resistant design and construction of structures in flood hazard areas.

National Flood Insurance Program (NFIP), Federal Emergency Management Agency (FEMA), www.floodsmart.gov

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C. Appendix C: Data Used to Develop Flood Risk Products

Editorial Note: This appendix will include paragraphs of free-form text describing the data leveraged by the local/state stakeholders in the production of this Risk MAP project.